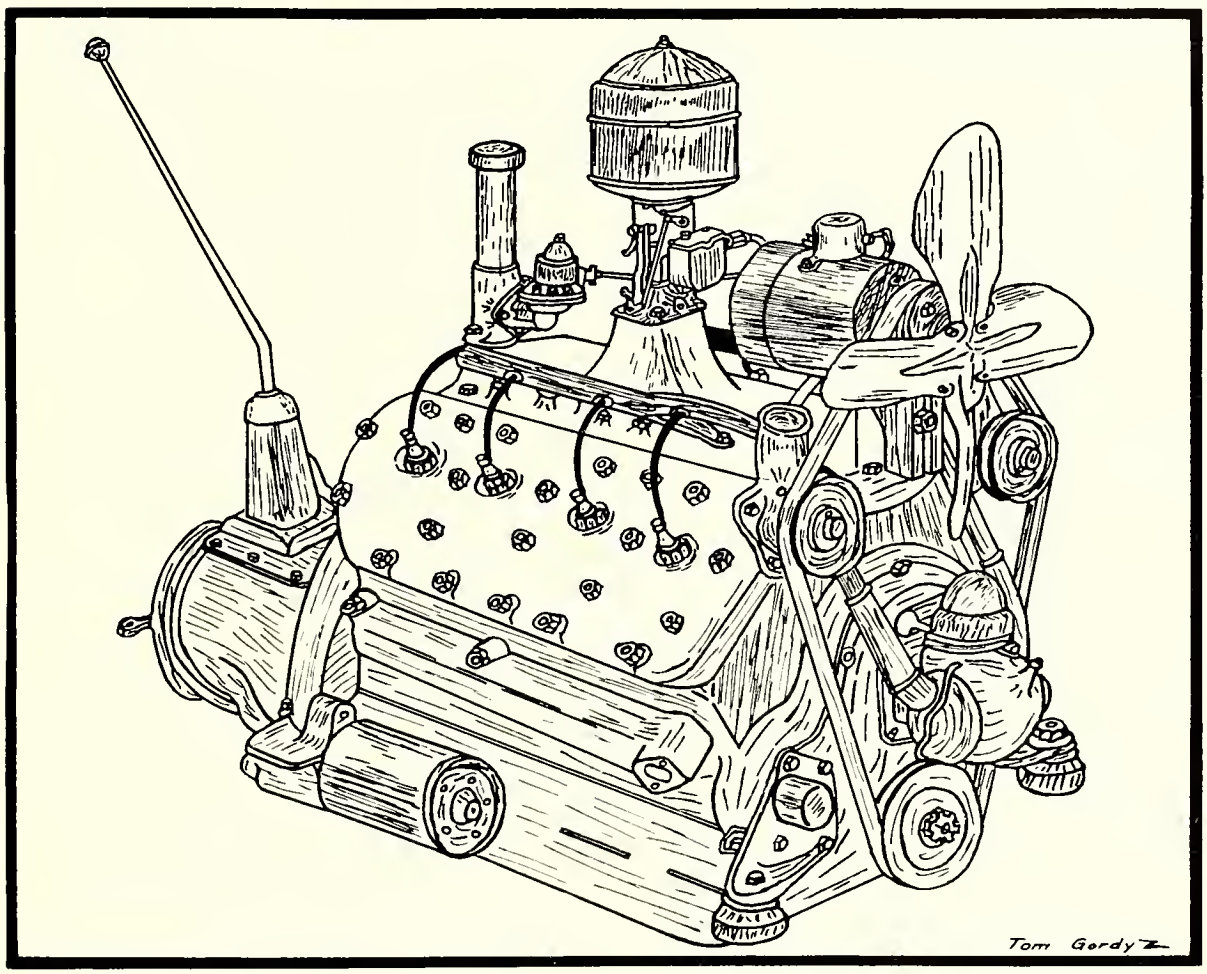
The Carolina Engineer

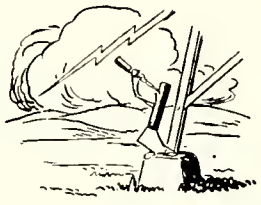


SCHOOL OF ENGINEERING
University of North Carolina

MARCH, 1934

VOLUME 2 NUMBER 2

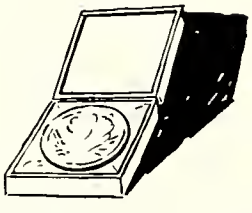
G-E *Campus News*



LIGHTNING SPIES

How many amperes are there in a bolt of lightning? Well, there are too many for comfort, and most of us are willing to let the matter rest there. General Electric engineers, however, were very much interested in knowing, so that they could better protect electric transmission lines and equipment from damage by lightning. And last summer they sent out over 2000 little spies. These spies are metal cartridges, hardly an inch long, which were placed on the legs of transmission towers on lines in Pennsylvania and Virginia. This territory is apparently one of lightning's favorite hangouts. When the surge from a lightning bolt passes through a transmission tower, the little spy is magnetized in proportion to the highest current in the bolt. Linemen carry the magnetized spies back to headquarters, where, when placed in a "surge crest ammeter," they tell their story. Many scores of the little spies have reported, and their stories are really shocking. The highest reading has been 60,000 amperes.

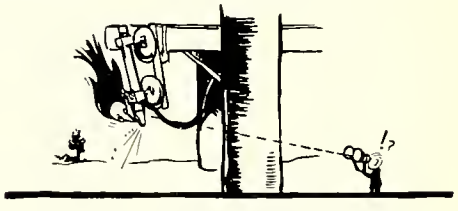
Clifford M. Foust, Carnegie Tech, '21, and Hans P. Kuehni, Ecole Polytechnique Fédérale, Zürich, '20, of our General Engineering Laboratory force, were responsible for the spies and the meter to make them talk.



KEYS, MEDALS, AND RESEARCH

The engineers and scientists of the General Electric Company have individually received many keys of honorary societies, medals, and other tokens. On February 1, however, General Electric received a medal to hang on its collective chest. The donor was the 100-year-old American Institute of the City of New York. And the citation read: "For pioneering in industrial research . . . for great achievements in pure science that have furnished gainful occupation for thousands of workers and that have raised the standard of living, and increased health and happiness."

We mention this with pardonable pride, fully aware, however, that medals and honors are not the purpose of research. The real purpose is the discovery of fundamental facts at the border line of man's knowledge. The practical applications are worked out later. It was with this conviction that Dr. Willis R. Whitney, M.I.T., '90, Ph.D., Leipzig, '96, now vice-president of the company, in charge of research, organized the G-E Research Laboratory in 1900. In maintaining this tradition, he is ably assisted by Dr. W. D. Coolidge, M.I.T., '96, Ph.D., Leipzig, '99, the present director; Dr. Irving Langmuir, Columbia, '03, Ph.D., Göttingen, '06, last year's winner of the Nobel prize in chemistry, associate director; Dr. Saul Dushman, U. of Toronto, '04, Ph.D., '12; and Dr. A. W. Hull, Yale, '05, Ph.D., '09, assistant directors.



SOUTHERN SLEUTHING

Not since Cock Robin have our feathered friends figured in a real good mystery, until the other day. And this was not so much a case of violence as of mistaken identity. Down in South Carolina, a power company had been having a little difficulty. It seems that the cutout fuses, which serve the same purpose on electric distribution lines that fuses do in our homes, were blowing out without apparent reason. Finally, an engineer with a Bird Club in his past unraveled the mystery. He saw a bird pecking at the soft fuse wire, apparently having a fine time. (It wasn't a G-E fuse.) Breathless investigation showed that other circuits had been opened in a like manner.

A G-E salesman on his next call recommended our new fuse links. Having copper in that part which the birds attacked, they proved to be im-peckable, and the trouble ceased. Now the birds are concentrating on worms, the power company on G-E fuse links, and everybody is happy.

NRA WE DO OUR PART

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GENERAL ELECTRIC

The Carolina Engineer

The Professional Journal of the School of Engineering

University of North Carolina

VOLUME II MARCH, 1934 NUMBER 2

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E·D·I·T·O·R·I·A·L

W. E. Davis—*Editor*

ENTERETH THE NEW STAFF

With this issue of the *Carolina Engineer*, the present staff turns over control of the magazine to the incoming staff. Rather than to continue our tenure of office till the end of the year, it has been thought better to install the new staff with the May issue in order that they may have some experience with the problems of the magazine before next year. In this way, they will have the old staff to consult on problems arising in the publication of the magazine.

Apparently, the custom is for the old staff of a magazine to break down in the last issue and admit its sins of omission and commission, and to urge the incoming staff to greater achievements than the present one has accomplished. It has been a little difficult to adopt and show a definite editorial policy on the basis of two issues. The present staff has attempted to secure a greater student interest in the magazine by the usage of articles directly or indirectly pertaining to the students and the Engineering School. The staff has endeavored to secure the interest of the alumni of the Engineering School by the inclusion of an alumni column and by a drive for subscriptions from these alumni. Efforts have been made to comply with the requirements of Engineering College Magazine Associated for membership in this body. Part of the requirements have been met, but much still remains to be done by the incoming staff. So much for our difficulties, and now for a look at the problems facing the new staff.

Probably the greatest difficulty the new staff will have to face is the lack of interest by the engineering students in the magazine. This is a little difficult to understand since the magazine was formed primarily to give the students an opportunity to obtain experience in engineering writing and to acquaint them with various problems of engineering and their solutions. Obtaining articles for the magazine by students is apparently harder than securing the proverbial hen teeth. The magazine belongs to the students —there is no reason why they should not write for it. The majority of the students plank down their fifty cents, secure their copy, and if feeling in a particularly generous mood may read one, or possibly two, of the articles in the magazine. In order to secure their money's worth, they should write for the magazine as well as to pay for it. To paraphrase Ellis Parker Butler's famous book, four bits is four bits.

The present staff turns control of the magazine over to the incoming staff with our hopes and best wishes. It has been enjoyable, even if only for two issues, and the staff hopes that in some ways it has improved the general interest and appearance of the magazine. It remains for the new staff to continue where we left off. To achieve anything, the staff will need the support of the entire Engineering School.

A CLOSED ENGINEERS' BALL

Last quarter when the suggestion was made that the annual Engineers' Ball be made a closed affair, a great deal of opposition was raised. It was claimed that there would not be enough girls at the dance. Some of the more financially-minded engineers asserted that enough bids could not be sold to defray the expenses of the dance if it were a closed affair. It was claimed that making the dance closed would result in greater drinking. Another claim was that it would be impossible to make the dance a closed one. Let's take a look at some of the claims and their answers.

There can be little doubt that there were enough girls at the dance. Till the last bid was sold, date bids were outselling stag bids at least three to one.

As to the possibility, financially, of having a closed dance, not one cent was assessed any of the engineering societies which were backing the dance.

One of the reasons it was advocated to make the dance a closed one was to discourage excessive drinking. That closing the dance was successful in this respect is shown by the fact that several of the faculty members have stated that there was less drinking at the past dance than any of the Engineering School dances they had attended and by the fact that it was unnecessary to put anyone off the floor for drunkenness.

So far as keeping every person other than engineers out of the dance, it was never deemed possible, practical, or advisable by the dance committee. What the committee urged was the elimination of the practice of anyone and everyone attending the dance who so desired. That they were successful was amply evident at the dance.

Thus, it has been shown that having a closed Engineers' Ball is not only possible but advisable. Several of the faculty members have stated that it was the most enjoyable Engineers' Ball they have seen. The merits of a closed dance are evident. May we have more of them.

THE CAROLINA ENGINEER

VOLUME II MARCH, 1934 NUMBER 2

Public Utility Regulation in Southern States

By W. L. RIDENHOUR

(EDITOR'S NOTE: *The following article won third prize for student papers at the Regional Southeastern conference of the A. I. E. E. at State College in Raleigh, January 12, 13.*)

The electrical power industry has assumed a place of great importance in the economic and social life of the country. It has revolutionized the daily life of the average American, entering into the operation of the greater part of our modern conveniences.

The companies supplying this necessary power are, by nature monopolistic. A customer will probably have at his disposal the services of no more than one, or at the most two, companies. He may not buy power from one company today and another tomorrow. Furthermore electricity may be generated more economically at some particular sites, or in some districts, and immense capital is necessary for the establishment of a power company.

Since Electrical Utility Companies are so intimately connected with the public good, they are, in effect, public servants, and since they are monopolistic by nature, it is natural that some form of regulation is necessary. Their personnel must be regarded as semi-public officials. Efficiency in Public Utility Companies will benefit the public, and inefficiencies must be paid for by them. Consequently the public has a right to demand that the industry shall be developed with social welfare as well as the good of stockholders in view.

Formal Electrical Utility Regulation in the United States dates, perhaps, from 1907. Regulation has been constantly developing, expanding, and crystallizing its policies since that time. The process is still going on, and will probably continue to do so for some time, or until a system, either of State or National Regulation, or of Public Ownership has evolved which is satisfactory to both producers and distributors of power, and to consumers.

The policies of the present administration, with its gallant attempt to restore national prosperity, by constitutional methods, and the usage of unprecedented power by the president, and in particular the Government Development of Muscle Shoals which directly and vitally affects the Southern Power Companies—especially those of Tennessee, Alabama, Mississippi, and Georgia—bring this question of Utility Regulation to a focus at this time and make a discussion of the "status quo" and the factors to be considered rather appropriate. Is this the beginning of a movement toward government ownership, or merely a Public Works project? Perhaps the advocates of private ownership should inspect the present system and give it a thorough overhauling so that private ownership may have a fair chance to prove its worth. Should Public Utility Regulation be condemned on the basis of its past history? It appears that an adequate system of Commission Regulation has never been in effect. There are factors which prevent the adequate functioning of Utility Commissions as they are organized today.

Forty-seven of the forty-eight states have power commissions of one type or another, and attempt the regulation of Public Utilities through these commissions. Only forty of these commissions have jurisdiction over Electrical Utilities, and a large number of this forty are rather limited in authority as will be shown later.

The chief purpose of this paper is to analyze the regulatory bodies of the Southern States. Before this is done, however, the general principles and requirements of Regulation and Regulatory bodies will be reviewed briefly. It is not the purpose of the paper to advocate any system of utility control, nor to indict the present system, but rather to point out certain essential facts which must be considered before any system can be advocated or condemned. An attempt has been made to study and set forth the characteristics and status of the present regulatory bodies in the Southern States. To aid in this study a group of eleven states has been chosen, namely: Alabama, Georgia, Florida, Mississippi, South Carolina, North Carolina, Virginia, West Virginia, Tennessee, Kentucky, and Louisiana. An effort has been made to answer a number of questions for each of these states.

The material for the answers has been procured by inquiries sent to the several states, and from literature furnished by these states. Standard works such as *Public Utility Regulation* by Morris Llewellyn Cooke, *Electrical Utilities* by William E. Mosher and others, and the Bonbright

Survey of State Utility Laws were used as references. An effort will be made to draw conclusions from these answers and to determine just what efficiency and satisfaction the public obtains, and as a comparison, just what should be expected. What requirements should the commission as a whole, and each commissioner personally, possess? Finally, a plan for an ideal commission will be drawn up, rather as an ideal towards which states might work.

The basis for regulation of Public Utilities in the United States is the Fifth and Fourteenth Amendments to the Constitution. The clauses embodying this authority are as follows: From the Fifth Amendment: "No person shall be held to answer for a capital or otherwise infamous crime, unless on a presentment of indictment of a grand jury, except . . . .; nor shall any person . . . . be compelled, in any case, to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use without just compensation." From the Fourteenth Amendment: "Nor shall any state deprive any person of life, liberty, or property without due process of law, nor deny to any person within its jurisdiction the equal protection of the laws." . . .

The Utility Corporations come under the designation of "person" in these amendments since the corporation is considered to have the rights of a private citizen before the law. It is significant that these amendments do not specifically prohibit the states from taking private property without just compensation. In interpreting the words, "due process of law," however, where life, liberty, or property are involved, the United States Supreme Court has held that "due process of law" includes "just compensation," and the constitution has been "judicially amended."

Let the field of regulation now be surveyed briefly. A general outline of the particular functions which commissions should regulate will be made, and therefrom the desirable qualifications of commissioners may be developed.

In the first place Public Utility Commissions must regulate railroads, water and gas companies, and possibly interurban lines in addition to their control of Electrical Utilities. In fact some of the commissions are known as "Railroad Commissions," and some do not regulate Electrical Utilities at all. The factors which the commission should control are, in part, as follows:

1. The rates charged to customers.
2. The quality and amount of service rendered.
3. The accounting system of the Utilities.
4. The operations of Holding Companies and the types of securities issued by these companies.
5. The type and quantity of securities issued by the Utilities.
6. Water and land rights and franchises.

Regulation of rates is without meaning when disconnected from the regulation of services. That is, a charge of 7 cents per kilowatt-hour is not comparable with a charge of 2 cents per kilowatt-hour if the voltage fluctuates widely, or if service is frequently interrupted under the 2-cents rate. The customer desires efficient and satisfactory service at the lowest possible cost. In order that this condition may be obtained the commission should have jurisdiction over the service which a company must render. Let it be said here that this is probably, in general, the best handled function in the hands of present commissions. Legislation has fairly closely fixed the time and method of paying rates, and prescribed rules for the inspection and accuracy limits of meters. Some commissions have authority to control extension of service into rural and undeveloped sections.

It would be quite impossible to determine fair rates on the percentage return basis, or to control financial operations without some authority for the inspection of a Utilities books. Therefore it is only fair to assume that commissions which do not have the power to inspect the books of Utility Companies cannot exercise adequate control over Public Utilities. There are only thirty-two states in the Union which provide their commissions with this accounting authority, and even in these the control of accounting may not be adequate. "Failure to supervise the accounts of utilities is one of the primary weaknesses of state commissions," says W. E. Mosher in his book, *Electrical Utilities.*

Another necessary commission function is that of controlling the quantity and kinds of securities issued by the Utilities. This field has been one of corruption in the past, since officials have been more interested in juggling securities for their personal advantages, than in operating a public service utility. Commissions should be empowered to prevent stock-watering, over-capitalization, and manipulation of accounts. Obviously any fraud exercised in making up statements of operating costs would prevent any fair rate adjustment. Authority over accounting systems is vested in twenty-five of the states in the Union. (1929)

One difficulty with the situation is that many companies were organized before the commission system was originated. Therefore no control over the capitalization of these concerns was possible.

Then there is the Holding Company, which is

usually interstate in nature. A holding company is not a utility and rends no direct public service, consequently it is not subject to state commission control. The operations of these companies do, however, affect utilities and utility regulation to a great extent. In the first place Holding Companies often compete for the securities of operating companies, causing an inflation of security prices. The company will, however, demand that the commission base its valuations upon this inflated security price, and consequently the rate base may be exorbitantly high. The public must not only pay the Utility a fair return upon its expenses and capitalization but also on the inflated value of the Holding Company securities.

Furthermore these securities issued by the Holding Company are usually secured only by the *earnings* of the operating company, and as such are all of a class with income bonds. While this, in itself, may not be an evil, the fact that the Holding Company conceals, or at least does not openly advertise, this fact causes investors to trust their funds to unknown Holding Companies when they think they are buying the securities of a reputable Operating Company, on whose surplus earnings the securities may be based. It often happens that the Holding Company may default, while the operating company remains entirely solvent.

From the above it may be seen that lack of power to properly supervise Holding Company operations constitutes a weakness in commission control. Consequently it is believed that commissions should be authorized to control the relations between Utilities, Holding Companies, and Construction Companies — to exclude all inflated stock values from rate base calculations, and to directly supervise Holding Companies. When this provision has been made a step will have been taken toward adequate commission control.

If the power companies are to be forced to provide service at definite rates should not their interests be protected as well? That is, unsound competition should not be allowed to spring up. The commission might, therefore, control water rights, and power franchises for new companies. In this way water rights may be developed only as the need for power arises, keeping down overproduction and the consequent failure of Utilities. Control of the utility franchise will prevent the erection of Utility companies which fill no economic need, or are of unsound structure.

The central question in the discussion of the duties of commissions is the fixing of rates. After all it is rates and service which the customer is interested in. Since a monopolistic industry would naturally tend toward the charging of exorbitant rates, it is the duty of a state commission to so fix the rates that the operating company can earn a fair return on the investment, and yet provide fair rates and adequate service. An 8% return on investment is generally considered a "fair return." It is by no means a simple matter, however, to determine just what an 8% return will be. There is the theory evolved by commissions after years of experimental rate making, which states that "rates should be based upon production costs including all operating expenses, interest on borrowed money, and dividends on invested capital." In apparent contrast to this the Supreme Court handed down a decision in the *Indianapolis Water-Rate Case* to the effect that the courts would declare the rates confiscatory "unless the commissions should allow the utilities to earn a fair return upon the estimated cost of reproducing their properties at prevailing price levels with due allowance for intangibles."

This determination of reproduction cost has been a great stumbling block to effective regulation. There has been no end of controversy as to what the basis of reproduction should be—as to how much depreciation should be figured—and how much of the property must be reproduced. Here is a field for the display of legal talent hired by the utilities. Here is where the lack of trained personnel and financial talent on the Commission staff has hindered effective regulation.

Under a system of adequate regulation commissions should be equipped with adequate legal, engineering, and financial personnel, as a part of the commission and not as advisory staffs. When a technical expert is being paid for full-time service on a commission it is reasonable to suppose that he will devote more time and show a greater interest, than if his capacity is advisory only. In the first case he has full responsibility, in the second he has limited responsibility.

The commission might well be further empowered by legislative act to set a definite standard for rate making which would be applicable in all cases. It follows from this discussion that a commission should comprise, as a minimum, a capable engineer, a man with legal training, and a financial expert. Perhaps an engineer with wide experience in utility and economic fields would possess all the necessary qualifications, and three of such people could be called in as a commission. These men should devote their full time to the work of the commission.

These commissioners should be well paid, since really good talent may seldom be obtained without adequate compensation. A mere competent commission would certainly save the taxpayer more than the additional cost resulting from more complete regulation and better-paid com-

missioners. It is possible that the actual cost of regulation would be increased by the installation of a really competent commission. In the Southern States the general number of commissioners hired is three, and since these are paid only an average of $3,500 per year, any better personnel would cost more, since the number of commissioners could not well be decreased. Three $10,000 men might be more to the point. By a $10,000 man is meant a man who has the training and experience essential for the carrying on of the commission functions outlined above. States like South Carolina which hire six $2,400 men, and a $2,700 chairman might install the new commission with only slightly increased costs.

In addition to the many benefits which society would receive from rate reductions, better service, and proper security supervision resulting from better regulation, the new commissioners would be able to carry on the actual investigations themselves and would largely eliminate the necessity for hiring staff advisors. The commissioners would actually be the regulators instead of bodies to whom the technical staffs might report. This would naturally eliminate the extra expense of hiring staff help. The total cost increase might therefore well be small, or possibly negative.

Now that the general aspects of regulation have been reviewed the discussion will be confined to the Southern States. The questions which we have attempted to answer were considered particularly pertinent to the present situation. It may be noted that all of the blanks of the chart are not filled in, denoting that the missing information was not available.

The data for Alabama, North Carolina, Florida, South Carolina, and Georgia was taken from letters which were very kindly supplied by the several states. Most of the other states contributed valuable data, which, however, was not quite so applicable to the present paper. The remainder of the information was gleaned from general reading or taken from tables in *Electrical Utilities* by Mosher and others, and from Bonbright's *Survey of State Utility Laws.*

The questions asked are as follows:

1. Does the State have a separate Public Utility Commission?
2. What body acts on Utility matters?
3. When was State Commission first appointed?
4. How are commissions appointed?
5. How many members constitute the commission?
6. What are the qualifications of commissioners?
7. What salaries are paid to commissioners?
8. Do commission duties require full time employment?
9. Does the Commission have competent engineers attached to its staff?
10. Is the Commission permitted to employ engineers for each case?
11. What authority does the Commission have?
12. What is the typical procedure in a rate case?

The findings of the investigation are presented in Fig. I on page 13.

Authority of Public Utility Commissions in Southern States

	Capit. & Security	Val. for Rates	Rates & Sched.	Accounts	Annual Reports	Service	Consol. & Mergers	Change Contract Rates
Mississippi	No	No	No	No	No	No	No	No
Alabama	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
West Virginia	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Virginia	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Tennessee	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
North Carolina	No	Yes	Yes	No	No	Yes	No	No Prov.
South Carolina	No	Yes	Yes	Yes	No	Yes	No	Limited
Georgia	Yes	Yes	Yes	Yes	Yes	Yes	No	No Prov.
Florida	No	No	No	No	No	No	No	No
Louisiana	No	Yes	Yes	No	No	Yes	No	No Prov.
Kentucky	No	No	No	No	No	No	No	No Prov.

FIG. II

The data displayed by the chart will probably bear further discussion. It will be observed that all of the states have utility commissions of one kind or another. Florida, South Carolina, and Kentucky, denote their regulatory bodies as "Railroad Commissions." These various commissions act on utility matters in all cases, but in Florida, Kentucky, and Mississippi, have no jurisdiction over privately owned Electric Light and Power Companies. Until 1933 the jurisdiction of the North Carolina commission was limited, there being no control over security issue, accounting, and no reports were required. So far as can be determined the power of the commission was not extended by the 1933 Legislature, which did, however, alter the commission form.

The dates of the beginning of the regulatory bodies seem to center around the last twenty years of the 19th Century, or from 1880 to 1899, with the exception of that of West Virginia, which was founded in 1913. From this it would seem that commissions have been in existence long enough to have their policies rather well outlined. The main factor which must be considered, however, is that the industry is con-

(*Continued on page thirteen*)

The Construction of the Chapel Hill Reservoir

By F. E. Culvern

The growing enrollment at the University of North Carolina and the increasing population of the town of Chapel Hill have made it necessary to change the source of the water supply several times. Water was first supplied by a spring near the present site of Graham Memorial. Later, a well was dug between Old East and Old West in front of South Building. Water from these sources had to be carried to the dormitories in buckets. Running water, which was pumped from a well at the site of Phillips Hall, was installed in the 1890's. The well supply proved inadequate; so

Fig. 1

a pipe line was laid to Bolins Creek. A steam pumping station, which was later electrified, was built to supply the water to the pressure filter at the university. The pressure filter was unsatisfactory; so, in 1913 a gravity filter was installed and was used until the present filter plant was built in 1925.

In 1921, Bolin Creek went dry and a pipe line was laid to Morgans Creek. Two years later the present pipe line was constructed, and a small weir, which provided very little storage, was built. It was estimated that the flow of the creek would be sufficient to supply the needs of the university and of the town of Chapel Hill. In 1925, the year of the lowest rainfall on record, it was found that the Morgans Creek was inadequate; therefore, another source was sought. Three possible locations were considered: a site on Prices Creek about 8 miles from Chapel Hill, a site on upper Morgans Creek about 14 miles from town, and the present site on lower Morgans Creek. The upper site did not meet the requirements, as its drainage area of 5 sq. miles was too small to supply the amount of water needed, and also the long pipe line was too expensive to construct. The cost of developing the lower Morgans Creek site was more than the amount originally appropriated; so the Price Creek site was decided upon. A complete set of drawings were made for locating the dam there. Later, when it was found that enough money could be obtained to construct a dam on the lower Morgans Creek site, the plans were changed and the present dam was designed by T. C. Atwood of Atwood and Weeks and was constructed by T. C. Thompson & Co. during the spring and summer of 1932.

The dam is concrete and of the simple gravity type. It is 380 ft. long, 30 ft. high, and 34 ft. thick at the base. The spillway is 250 ft long. Specifications for the dam required that the foundations be on solid ledge rock with keys 5 ft. deep and 5 ft. thick on both the front and the back edge of the dam (Fig. 1).

To determine the depth of the rock ledge, soundings were made by means of ½ in. steel rod driven into the ground in the following manner: a heavy cylinder is allowed to slide down the rod until it strikes another cylinder which is fastened firmly with set screws. The force of the impact drives in the rod. When the fixed cylinder reaches the ground, the set screws are loosened and it is moved up to a height of about 4 ft. above the ground, the set screws are tightened, and the operation is repeated. After it is impossible to drive the rod in any farther, the ground point is marked on the rod, and it is withdrawn. It is then moved about 4 ft. and driven in again. If it does not go an appreciable amount deeper, it is assumed to be on solid ledge rock. If it does go a great deal deeper, it shows that the first stop was

Fig. 2

probably caused by a large rock. This operation is repeated at 10-to 15-ft. intervals all the way across the section of land that is to be excavated. By this method, the surface of the ledge rock is fairly accurately determined. After the surface was determined, a diamond core-drill was used to

cut out samples of the rock for inspection.

From the above data, the amount of earth and rock to be removed was estimated. The original estimate was that 6000 cu. yd. of earth and 1500 cu. yd. of rock were to be removed. When the ledge was reached, it was found to be a friable shale with large seams and cracks running in a direction perpendicular to the face of the dam. This condition was considered unsuitable for the foundation; therefore, the excavations were carried 20 ft. into the ledge, necessitating the removal of approximately 8500* cu. yd. of rock.

Since the foundation was so deep, one key on the face of the dam was deemed sufficient. After the required depth was reached, the exposed surface of the rock was thoroughly brushed and washed to remove sand and loose rock. It was then moistened and sprinkled with raw cement which mixed with the little remaining sand to form a very rich mix, and to produce a strong bond between the dam and the foundation rock.

A two-yard batch-mixer handled the concrete which was poured continuously until 130 to 275 cu. yd. were placed. The concrete was carried from the mixer to the place of pouring in a bottom-dumping car hauled by a tractor which ran on a trestle above the dam. Two 12-in. adjustable-length galvanized iron tubes were used to place the concrete. The mix was "worked" by special tamps and by having men walk over the freshly poured concrete and pack it with their feet. (Fig. 2). A very dense concrete was secured.

Native stone crushed at the site and sand which was dug nearby were used as the aggregate. Lehigh Portland Cement and Magnolia Cement were used in the ratio of 1 bag of Magnolia Cement to 3 bags of Portland Cement. The Magnolia Cement was used to give a light pleasing color to the concrete. The dam contains two different grades of concrete. A strip 2 ft. thick on the face of the dam is a 1:2:3¾ mix; whereas, the remainder is a 1:3:5 mix. Both sections were poured simultaneously. A board was kept between the two parts of the concrete while it was being placed, but it was raised as the pouring progressed, thus the parts flowed together while still wet and left no construction joint. The dam is reinforced on the face with 7-8 in. round bars placed vertically and spaced 12 in. on centers. Three-eighth inch round bars, placed horizontally 4 ft. on centers, served to keep the vertical bars in place during construction.

The dam was poured in horizontal sections 30 ft. long from 7 to 14 ft. high. On each step a key 1 ft. deep and 2 ft. wide increases the bearing surface and the shearing area of the section. Between each horizontal section, a number of large stones increase the bonding power; however, no stones are placed within 2 ft. of the face. Some large bolts, which were removed from Old Memorial Hall when it was torn down, were placed vertically in each section. Their original purpose was to anchor buttresses for supporting a wall on the face of the dam. It was not necessary to use them for that purpose as enough money was obtained to complete the dam as proposed. They were left in the dam to increase the bonding strength between the sections.

As the dam was poured in 30-ft. sections, vertical construction joints were necessary. Water is likely to seep into these joints; so, in the first key of every vertical construction joint, a strip of copper stops any water that may seep into the joint. Each key is painted with tar to prevent bonding. If the keys were to bond with the next

FIG. 3

section and if lateral expansion were to occur, it is possible that they would crack along the line of the construction joint.

The spillway (Fig. 3) is 250-ft. long with a 30-ft. section in the center which is 1 ft. lower than the remaining 220 feet. A groove in the low section provides the necessary key in the construction joint so that if it is desired to raise this section to the level of the remainder of the spillway, it can be easily done. At the top, the spillway is round, but it gradually flattens out as it joins the downward section. The bottom is curved slightly upward. As the water leaves the spillway, it is thrown into the air and most of its force is expended before it strikes the ground, thus the wear on the foundation is diminished; however, very little wear is expected as the water strikes solid rock. Two-foot sections of 2-in. brass pipe, spaced 4 feet on centers, are sunk flush with the top of the spillway. A larger head can be obtained by putting iron bars into the pipe sections and placing boards against them. The pressure of the water will hold the boards in place, thus giving an additional head of two or three feet.

After the dam was placed, the task of filling

(*Continued on page fifteen*)

Blasting in Highway Construction

By R. M. Dailey

Today, as highways are mostly built or relocated on a straight line between points, it is often necessary to cross large areas of either rocky, sandy, or swampy lands. Hence, it frequently proves necessary to employ blasting methods in road building.

Probably the most interesting methods of blasting employed in road work are those used in the formation of foundations for highways over muddy and swampy lands. These methods, developed by the du Pont Company, introduce a relatively new and important use for explosives in construction. They emphasize the value of explosives as time-savers, and present new ideas and opportunities for the application of engineering principles, research, and experimentation.

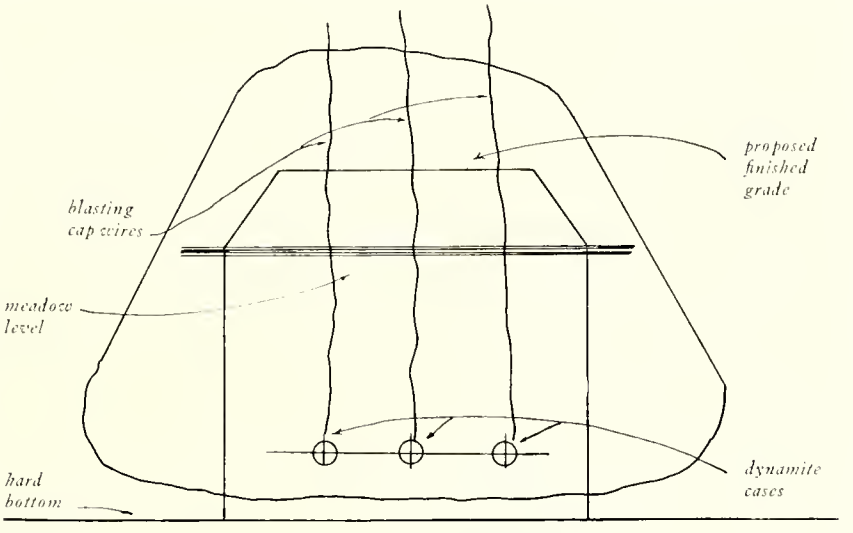

FIGURE 1—*Elevation*

In general, two methods are used advantageously in the forming of foundations for roads over swampy lands. The first method is performed by blasting as large a ditch as possible along the center line of the proposed highway, and then filling in the ditch and piling up a sufficient quantity of material to cause a considerable natural settlement. The second method consists of placing the fill material on top of the marsh, and then loading the dynamite underneath. Then, when the dynamite is touched off, the force of the explosion pushes the muck to the side, and the fill settles into place, because the lateral resistance of the muck and semi-liquid mud is far less than the pressure of the great weight of earth piled along the highway right of way.

The quick settlement of the road fills has been developed to such an extent by these methods that permanent concrete slabs may be laid in a few months after the blasting operation. A period of from five to ten years was formerly required to permit the foundation to become solid, and then uneven spots frequently developed.

Two methods of loading the road bed in preparation to blasting are commonly used. The first is carried out by placing the boxes of explosives in a triangular system, at designated points on the road line, and then dumping the fill material on top of the boxes (Fig. 1). Each box of explosives contains a cartridge primed with an electric blasting cap. Attached to each cap is a wire, carrying current from an electric blasting machine, which is used for detonating the charge.

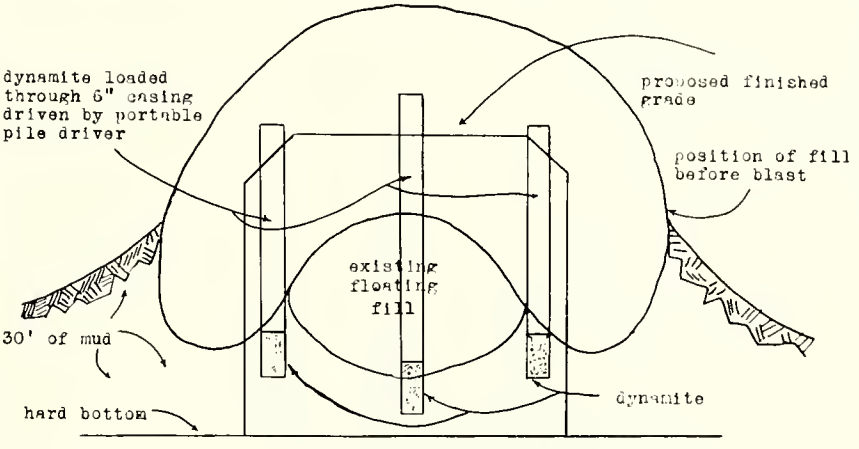

FIGURE 2—*Elevation View*

The second method of loading is performed by lowering the explosives through pipes or casings sunk in the fill material to the desired depth (Fig. 2). Before loading, however, a small charge is lowered to the bottom of the casing and exploded electrically to form a pocket in the muck of sufficient size to receive the working charge, usually 150 lb. of dynamite. The casings are removed before heavy shooting is begun.

Before depositing the fill material on a road

(*Continued on page sixteen*)

Here and There in Engineering

By WALTER KING, JR.

Goat Levelling

According to Charles Oldberg, an American engineer in Russia, the old Armenians had a unique method of levelling which they used in connection with their canal building. Supposedly a goat will not go uphill or downhill voluntarily, so the Armenians would head a goat in the right direction and as the goat traversed the contour they would stake down behind him.

Too Many Volts

Many of our inquisitive electricals have no doubt wondered why 110 volts are commonly used instead of an even which would simplify calculations. According to the story, Edison originally intended that we should have the 100 but a mistake in calculations resulted in 110 instead of a 100.

Roman Land Surveyors

To the Roman land surveyors goes the credit for saving the mathematical arts through the dark ages for the benefit of the revival of learning. The old Roman methods of surveying were hardly inferior to many present day practices and were in many respects like the system practiced in the United States just after the Revolutionary War. The Roman surveyors, too, were highly respected persons and were "honored with a more earnest attention than falls the lot of any other philosophers."

Quite a Guy

S. Timoshendo, Professor of Mechanics at the University of Michigan is quite an authority on vibrations and draws a large retainer fee from Westinghouse as a consulting engineer. On one occasion Westinghouse had installed a large motor in a building and the motor was about to shake the building down. After several efforts to correct the trouble had failed Professor Timoshendo was called in. The professor asked for blueprints of the building and the motor and shut himself up for a couple of days. Finally he reported that if a mere twenty-five pounds were placed on a certain part of the motor the trouble would be remedied.

As his name might indicate Professor Timoshendo is not a native of this country but is of the Russian nobility and a graduate of the University of Petrograd. When the revolution broke out he was teaching there at the University. Together with several other professors, Professor Timoshendo organized a travelling school and went from town to town organizing classes. Slowly the group progressed toward the border and finally slipped out of the country and came to the United States.

Half "Injun"; "Half Injun-eer"

Professor G. Wallace Smith tells a very amusing incident on the late Major William Cain, former professor in our engineering school and for whom the student chapter of the A. S. C. E. is named. In the early days Major Cain was doing some railroad surveying in the west and one day came across a small boy playing around the work. The major asked the little boy what he was.

"Part Injun; part Injun-eer" was the reply.

Blasting

Before the use of powder in blasting operations rock was either chiseled out or was split by building fires against the rock and then throwing water on the hot rock. Another method used in countries that permitted it was the chiselling of holes in the rock and filling the holes with water which froze and cracked the rock. Another method offered by the Romans was the pouring of vinegar upon rock. In fact Pliny has written that "vinegar poured upon rock in considerable quantities has the effect of splitting them, when the action of fire alone has been unable to produce any effect thereon." However, according to Hershael, the noted hydraulic engineer, "pouring on water in 'considerable quantities' and under like circumstances would have been as efficacious as the like quantity of vinegar."

Phillips Hall

Although we have heard several people being accused of designing Phillips Hall, Dr. Archibald Henderson seems to have the best story told on his architectural ability. So the story goes Dr. Henderson designed the building and had one brick left over and didn't know what to do with it. Finally he decided to use the brick for a door stop.

Try This One

Some young engineers in the G. E. laboratory were puzzled over the volume which would be common to two two-inch pipes if one were passed through the other at right angles. Finally, they asked Steinmetz, the electricity wizard, who worked the problem out in his head. The result is 5.33 cubic inches and a similar problem is in our calculus text.

Activities of the Engineering Societies

Tau Beta Pi

By WALTER W. KING, JR.

The North Carolina Beta chapter of Tau Beta Pi has been very active this quarter and has held several important meetings. The most outstanding event was the second tapping of the year which was deemed advisable to be held in the winter quarter rather than in the spring. Dr. Archibald Henderson spoke at this meeting after which the following men were tapped: W. C. Morrison, L. S. Tracy, and R. L. Huber. These men, all juniors, were selected from the upper eighth of their class.

On the night of the Engineers' Ball a banquet was held in honor of these new initiates. Acting-Dean Miller presided at the banquet which was held at the Carolina Inn. Guest speaker for the evening was Mr. Stanley Wright who has long been prominent in engineering circles in this state and is at present a member of the PWA with offices in Phillips Hall.

At various times during the year the chapter has luncheons to serve as a social gathering for the group and to enable the members to hear outside speakers on topics of current interest. This quarter the chapter had the pleasure of hearing Professor Schwenning of the Commerce School discuss the NRA.

A. I. E. E.

By W. L. RIDENHOUR

The outstanding A. I. E. E. activity for the spring quarter was the meeting of the Regional Southeastern Conference of the society, at State College in Raleigh, on the 12th and 13th of January. The morning of the 12th was devoted to routine business, and to the reading of student papers. Six were presented, and three prizes were awarded. The papers were judged on the basis of content, presentation, value in their field, and originality of content. The first prize was taken by R. B. Shores of Clemson Agricultural College, with his paper: "The Selection and Application of Photo-Electric Cells. The second prize went to R. S. Wellons of the Georgia School of Technology who presented a paper, "Mercury-Vapor Process of Generating Steam." The third prize went to W. L. Ridenhour, of the University of North Carolina, who presented a paper entitled, "Public Utility Regulation in Southern States."

On the morning of the 13th, the convention visited Duke University and the University of North Carolina and were conducted about the campuses on an inspection trip.

The local chapter of the A. I. E. E. held a meeting on January 11 at which time H. F. Stewart, chairman of the dance committee, reported on the action of the committee and recommended that the dance be held at the Carolina Inn, and that it be a closed affair. A paper on "Public Utility Regulation in Southern States" was presented by W. L. Ridenhour in preparation for the Regional Conference. The members of the society were served refreshments after adjournment.

A. S. C. E.

By WALTER W. KING, JR.

The A. S. C. E. has been conducting its regular meetings this quarter with the majority of meetings being devoted to the study of outstanding engineering projects. These studied have been supplemented by material and slides lent to the society by the national society, and have proven very interesting as well as educational. One meeting was devoted entirely to the showing of moving pictures of the "Stevenson Creek Experimental Dam." Following the student lecture on the dam, additional remarks were made by Professor Hickerson who has made a study of the dam and has made a personal visit to it.

Despite the excellent illustrated lectures, attendance has fallen off at the last few meetings and all civil engineering students are urged to attend the meetings which are held on alternate Thursday nights. The society officers are planning an important meeting to begin the new quarter and are inviting all unclassified engineering students who are interested in civil engineering. For this meeting the society is trying to get an outside speaker and refreshments will be served.

A. S. M. E.

By E. L. KENDRICK

The U. N. C. Student Branch of the A. S. M. E. held two major meetings during the winter quarter in addition to a number of joint meetings with the other Engineering Societies.

The first meeting was held on January 18, at which time two student papers were presented. One on "Style Trends in 1934 Automobiles," by Mr. Calder Atkinson, and the other on "Individual Suspension of the Front Wheels on 1934 Automobiles," by Mr. E. L. Kendrick. A program committee consisting of Mr. S. H. Pitken,

chairman; Mr. S. S. Meyers, Mr. R. B. Wilson, and Mr. J. D. Maynard was appointed to serve during the remainder of the year.

The last meeting was held March 1 for the competitive presentation of papers to select a representative for the regional conference of A. S. M. E. in Atlanta. The winner, Mr. P. R. Hayes, presented "An Investigation of the Failure of Cast Iron Pistons in an Automobile Engine." This paper will be presented by Mr. Hayes in Atlanta during the conference, March 26 and 27. Mr. E. L. Kendrick won the runner-up position and consequently the *Brashear Autobiography*, with his paper on "Building a Knock Testing Machine for Studying Detonation in Internal Combustion Engines."

The other men presenting papers and the titles of their papers were: S. S. Meyers, "The Determination of the Internal Viscous Damping Constant and Its Relation to Torsional Vibration"; Stephen H. Pitkin, "How Accurate is the Ordinary Mercury Thermometer?"; D. B. Morgan, "Wind Resistance of a Runner"; and A. A. Cohen, "Determination of Percent Inflow for Open-Throat, Closed-Return Wind Tunnel."

The judges for these papers were: Dean W. J. Miller, Prof. E. G. Hoefer, Prof. T. F. Hickerson, and Dr. A. C. Howell.

A. I. Ch. E.

By EDWIN A. GASKILL, JR.

The local student chapter of the American Institute of Chemical Engineers opened its first meeting of the quarter with a business discussion of the forthcoming Engineer's Ball. At the conclusion of business Dr. A. M. White presented the sophomore award for making the highest grades in the freshman class of chemical engineers to Robert M. Neel of Charlotte. The presentation was followed by a moving picture of the refining of lubricating oil. Dr. White gave a running account of the processes illustrated. The meeting was adjourned at the end of the picture.

At the second meeting the chapter, with a number of guests from the other engineering societies and the chemistry department, was entertained by a lecture on "Antiknock Fuels" given by Mr. L. W. Shanks through the courtesy of the Ethyl Gasoline Co. Mr. Shank's lecture was profusely illustrated with slides and was accompanied by a demonstration on a test engine of the effect of various substances on the knock properties of gasoline. The lecture was followed by a discussion after which the group adjourned to the chemical engineering laboratory where refreshments were served.

Philandering around Phillips

By WHOOSIS, *Friend of the Famous*

Many tales have come to the writer's ears, but one of the best is the recent one on a certain engineer who ruined a good knife trying to blow a fuse on the first floor of Spencer. I wonder if he thought there was too much illumination on the subject. What subject?

The recent Engineers Ball has been the topic for many lively discussions lately. The majority seem to have a distinct preference for a closed dance, such as the one given this year; but there are still those who champion the idea of an open dance. Incidentally, the same Ball has furnished this column with numerous items of interest.

What engineer almost had two girls on his hands for the Ball?

What sophomore danced during the entire senior no-break number?

What engineers were rather rudely interrupted when a certain person failed to knock before entering their rooms on the Saturday night following the dance?

What sophomore turned up at the Ball with his first date of the year?

What two mechanical seniors seemed to be having more than a mere good time at the Ball? Where did they go afterwards?

It is rumored that a certain graduate engineer doing research work is such a power with the fair sex that they even come to Phillips to see him. What kind of research is he doing?

What electrical and mechanical students spend their lab periods arguing about whether the Army or the Navy is the more powerful?

What junior electrical is rumored to be engaged and what started such a rumor?

What transfer student told one of the profs to come up to his house for a duck dinner?

A certain junior electrical's car broke down almost beyond repair. A short time after this, his girl who had been going to Meredith left to enroll at Queens. Wonder if there was any connection?

What senior was presented a stick of chewing gum by the members of his class and why?

What was the prof's reply to a hydraulics student who wanted to know how to remove air from a pipe running above the hydraulic gradient?

What senior during lab period, mistaking the prof for one of the fellows, told him in no uncertain terms to get to work. What was the prof's reaction?

PUBLIC UTILITY REGULATION IN SOUTHERN STATES

(*Continued from page six*)

stantly changing and growing more and more complex, calling for frequent and thorough revisions of policy. Thus the fact that commissions have existed for a number of years does not prove that their policies are adequately defined or modernized.

In Alabama the Public Service Commission is elected by the qualified electors of the state for a term of four years. The President is elected at alternate two-years from the members. Three members make up the body. The Governors of Virginia and West Virginia appoint their respective commissions for six years. The remainder of the states elect the regulatory bodies. The commission is elected by the legislature in South Carolina.

All states considered use three commissioners except South Carolina which uses seven, Georgia which uses five, and North Carolina which has only one, with provision for two part-time assistants.

The commission of Mississippi rates lowest in unit salaries paid, with $2,250 to members. The North Carolina commissioner is paid $4,500 per year, and two assistants who receive $25 per day and actual expenses while employed, provided the total yearly expense per man does not exceed $1,800, are provided for.

All states except Mississippi and West Virginia give the Chairman of their commissions extra compensation.

The qualifications which Commission members must have do not seem to be very rigid. Alabama has the most stringent requirements: Members must be competent persons and qualified electors. No two commissioners may be elected from one district, and no one holding any utility stock of any description may be elected. Georgia and North Carolina require that members hold no Utility Stock—Florida puts the ban on Railroad Stock. South Carolina definitely has no requirements, and none were discovered for the remaining states.

Full time on the job is specified in all cases where data was found, except for the assistant commissioners in North Carolina.

The states of Alabama, Georgia, North Carolina, South Carolina, and Florida have special engineers attached to their commissions. No data was available for the remainder of the states. The states mentioned above replied that their commissions were permitted to employ engineers for each case, and Alabama reported that since the regular staff was very competent, additional help was seldom required, but might be obtained if necessary.

The authority of the various commissions with regard to Private Utility matters may best be indicated by a table. This table shows different

ANSWERS TO QUESTIONS CONCERNING PUBLIC UTILITY COMMISSIONS IN SOUTHERN STATES

Question No.	1	2	3	4	5	6	7	8	9	10
Alabama	Yes	Public Service	1880	Elected 4 Years	3	Competent No U. Stock	$5000 Ch. $3000	Full Time	Yes	Yes
Georgia	Yes	Public Service	1879	Elected 6 Years	5	30 yrs. old No stock	$3600 Ch. $5000	Full Time	Yes	
West Virginia	Yes	Public Service	1913	Appointed 6 Years	3		$6000			
Virginia	Yes	St. Corp Comm.	1876	Appointed 6 Years	3		$4000 Ch. $4500			
North Carolina	Yes	Corp. Comm.	1899	Elected 4 Years	1 (2)	No stock but E.E.U.	$4500 $25 / day	Full Time (1)		
Louisiana	Yes	La. P. S. Comm.	1898	Elected 6 Years	3		$3000			
Tennessee	Yes	R. R. & P. U. Comm.	1883	Elected 6 Years	3		$4000 Ch. $4000			
Mississippi	Yes	R. R. Comm.	1884	Elected 4 Years	3		$2250			
Florida	Yes	R. R. Comm.	1887	Elected 4 Years	3	No R.R. Stock	$4000 Ch. $4500			
Kentucky	Yes	R. R. Comm.	1880	Elected 4 Years	3		$3000 Ch. $3600			
South Carolina	Yes	R. Road Comm.	1878	Elected 2 Years	7	None	$2400 Ch. $2700	"Practically"	Yes	Yes

FIG. I

phases of Utility activity which might properly come under commission control. This material is largely obtained from tables appearing in *Electrical Utilities*, and is corrected through 1928. (See Fig. II.)

From a close observation of the results it will be apparent that the *No's* are almost as numerous as the *Yeses*. This indicates that the commissions have no jurisdiction over the particular Electrical Utility activity work marked *No*. Obviously many of the Southern Commissions do not have proper jurisdiction over Electrical Utilities. In West Virginia alone the commission has authority to regulate Municipal Electric plants as to Accounting, Rates, Service, and Reports.

In all states under consideration cases may originate either with the customer or the commission, except: 1—In those states which have no jurisdiction over Electrical Utilities. 2—In Louisiana and West Virginia where no provisions are made for complaints or petitions originated by the commissions. So far as could be determined there are no laws against the Utilities appealing to higher courts in rate revision cases.

In all states the cases are referred to the Supreme Court as the final seat of authority. Some of these courts are designated as "Supreme Court," some as "Supreme Court of Appeals," and some as "Court of Appeals."

From the study of the various commissions it has been seen that the make-up, authority, and extent of the different state regulatory bodies vary rather widely, and are somewhat limited.

One fault with the commissions is that there are few or no qualifications imposed upon prospective commissioners. If commissioners were required to be especially fitted for the job, that is, to be experts in some line of activity, such as finance, engineering, or law, the resulting commission would be vastly more efficient. Qualifications of men who can do the work of rate fixing, inspecting, and accounting with all their complexities and variations are not easy to fill. The field is so broad and the responsibility so great that only men with excellent training and wide experience in the engineering field should be considered. Service with an operating utility should really constitute excellent training for a commissioner. Competent men cannot usually be hired for the salaries paid by the states at present, and in addition political connections have too much room to enter and cause poor selection of commissioners.

Now that the commissions have been briefly analyzed, perhaps an opinion as to just what an ideal commissioner and commission should be, would not be out of place.

First the requirements of the man will be studied. Utility Regulation is an engineering field and engineers should be the best trained for carrying on the work. By an engineer is meant a man who has the ideals of the profession—one whose opinion cannot be bought, who will not give an authoritative decision on a question until he has *all* the facts, who bases his decisions upon facts and not upon opinion or conjecture. In addition to his professional ethics the commission engineer must naturally have wide experience and knowledge. This is strikingly illustrated in the article by Mr. A. V. Guillou, Chief Engineer of the Public Service Commission of Wisconsin, in the current November issue of *Electrical Engineering:* "Engineers employed by the state commissions are called upon for the preparation of complete detailed valuations and appraisals of small and large properties; for studies of depreciation and operating expense; to inspect physical facilities and recommend changes necessary for safety to the public or employees, or for improvement in service; and for extensive work in the examination or preparation of rate schedules and the promulgation of rules governing the quality of service or business relations between the companies and their customers . . . . To meet these problems properly the engineer must understand design of the equipment which he is appraising or inspecting, yet his duties seldom include any actual design work. He must be familiar with the methods of operation of these properties, yet neither he nor the commission by which he is employed actually operates any utility. He should understand the legal principles governing his work, and be familiar with the financing of the companies with which he comes in contact and with the effect which financial requirements may and should have upon their operations. A large part of his basic information comes from the accounting systems and accounting reports of the utilities; hence, he must have sufficient practical knowledge of accounting to know how to get the figures he needs and to appraise their reliability and practical accuracy. He is called upon frequently to settle minor complaints of customers regarding bills, deposits, etc.; thus in addition to technical knowledge he must have an understanding of business methods and relationships.

The commission engineer often must present the results of his work to attorneys and executives, or from the witness stand where he is subject to cross examination. The ability to explain technical matters in non-technical language and to discuss controversial questions with those who are in an antagonistic frame of mind is more important than in many other fields of engineering work. (. . . . the engineer should take to his work

with a regulatory commission not only a technical education, but also an understanding of construction problems and methods that seldom is obtained except through several years of varied experience in the organization of an operating utility.")

This article shows quite clearly the immense field over which the commissioner, or his staff, must operate.

It has been fairly established that regulation is an engineering job, from the technical point of view. This fact has been supported by the exposition of commission duties in the early part of the paper, and magnificently set forth by Mr. Guillou, who is a commission engineer.

But how may capable engineers be chosen for commission work? Would it not be logical for the A.I.E.E. and the A.S.M.E. to pass upon the men who are under consideration? Such practice is common with the Medical and Legal professions. The Government considers a college degree to be desirable for all applicants for engineering work. Is regulation any less important? Let it therefore be said that it would be excellent for the A.I.E.E. and A.S.M.E. to pass upon the engineering knowledge or fitness for the technical duties to be performed, upon the integrity, the personality, and experience of the commissioners. To make it definite let three men be placed upon the ideal commission—men who have previously been endorsed by the Engineering Societies, and elected by the State Legislature. These men might well hold no utility stock while in office.

Now that the commission has been chosen, what powers shall it have, and for how long shall it survive? Certainly the life of the Commission should not be less than six years, since practical experience would increase regulatory precision. The commissioners should be paid the salaries required to obtain men of the required caliber.

The commission should have authority to regulate Rates, Service, Accounting, Security Issues, Contracts between Utilities, Holding Companies, and Construction Companies, and the utilization of water rights. The commissioners should be permitted to set up uniform standards of procedure and should have the authority necessary for the application of these standards. Under such conditions the commission should be held responsible for the development and utilization of proper procedures.

After all, rates are the primary field for regulation, and if such be possible, the commission should set up a definite and comprehensive system of rules upon which Reproduction Valuations are to be made, and definite methods of determining rates from these valuations.

In so far as is possible the commission should do as much of the actual work of valuation and investigation as time will permit, and in case they are unable to do all of the work, assistants with qualifications comparable to those of the commissioners should be available.

Such is the ideal commission. Possibly all or a part of the ideas would actually work in some states, maybe in all, possibly in none. At least the very discussion of regulation and of such a commission may direct the attention of engineers and students to this field of engineering activity, and remind them that the present system is by no means perfect, and that the system of state commission control should not be condemned on the basis of its present application, since in at least three of our Southern states the commissions have no regulatory power over Privately owned Electrical Utilities, and since in the remainder the commission system is not operating at its greatest efficiency.

THE CONSTRUCTION OF THE CHAPEL HILL RESERVOIR

(*Continued from page eight*)

the 265 seams in the foundation rock with a neat cement grout was begun. A 1½-in. hole from 4 to 10 ft. deep was drilled in each seam. Pipes were placed in these holes and caulked with oakum. As each one was placed, it was capped to prevent dirt and trash from falling into it. After the pipes were placed, the seams were blown out with air under a pressure of 120 lb. per sq. in. A pool of water was standing behind the dam; so the air bubbles could be easily seen rising from the seam. They were then washed out with water and the grout forced in. Pressure was applied gradually to allow the grout to permeate the small cracks and fissures and to avoid blowing it out of the back end of the seam. Finally the full pressure of 120 lb. per sq. in. was applied and left until the grout had partly hardened. The grout was 1 part Portland Cement and 5 parts water. Some of the seams held as much as 36 bags of cement, others held less than 1 bag.

A concrete core earth dam joins the north end of the main structure. It is made of native clay put down in 6 in. layers and rolled with a 3 ton roller. The pump house is located on the lower side of the dam near the north end. The house is reinforced concrete and was poured in three sections. The floor was poured, then the side walls, and last the roof.

There are 4 intake chambers. One is 3 ft. 6 in. square for the sluice gate. A 36-in. pipe is in place for the future power house, and two 18-in. pipes serve the pumping station. One of the pumping station inlets is 15 ft. down from the

top of the dam, and the other is about 6 ft. from the bottom. The one near the top is generally used; the bottom one is used only in case of very low water.

The bridge over the dam is 4 ft. wide and has a 3 ft. rail on both sides. It is held up by 12 in. I-beams supported on piers 6 ft. high and spaced 19 ft. from center to center. Most of the I-beams were taken from the stack room of the old library. A few had to be purchased. The wooden parts are of pine, creosote-treated.

Reservoir

The general shape of the reservoir is that of a dashund lying on its side, the legs being formed by Morgans Creek and Prices Creek. The level of the reservoir extends about a mile up Morgans Creek and about a mile and a half up Prices Creek. An area of 227 acres is covered to an average depth of 10 ft., giving a storage of 638,000,000 gallons of water. This provides an ample supply to take care of any shortage that might occur during the next 100 years. The estimate was based on the probability curve, using the 30-year rainfall record of Chapel Hill. An important item in the determination of the life of the project is the rapidity of silting. Arrangements have been made to determine the rate of silting in the lake. The elevation of the top of the dam has been very accurately determined, and eight concrete markers on each side of the lake are referenced to this elevation. Cross-sections of the bottom of the lake are to be taken at each of these eight pairs of markers at least once every three years, and if possible, every year. After a few years, it will be possible to calculate from the data thus obtained the time necessary for the reservoir to become useless. In addition to its value as concerns this reservoir, the data obtained will be immensely valuable to hydraulic and sanitary engineers all over the country as the rate of silting is a serious problem on every project where water is stored.

The drainage area for the reservoir is approximately 27 sq. miles. The average yearly run-off has varied from 0.03 sec.-ft. per sq. mile in 1925 to 32 sec.-ft. per sq. mile in 1924. A study of the probability curve showed that a run-off as low as that in 1925 need not be expected again for 45 years and a run-off as high as that in 1924 should not occur again in 95 years, but insofar as the minimum and maximum occurred within 2 years of each other, it would not be wise to place too much faith in these figures.

It has been conservatively estimated that the life of the present project will be 125 years.

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BLASTING IN HIGHWAY CONSTRUCTION

(*Continued from page nine*)

line across a swamp or marsh, preliminary shooting should be done to destroy the mat of vegetable growth and decayed vegetable matter which is often several feet thick. Otherwise such a mat will likely divert the fill material to one or both sides of the road area. Such shooting liquefies, in a measure, the mat substance, and permits the fill material to sink considerably by its own weight.

The use of explosives is particularly successful in this type of highway construction. Once the foundations have been formed, the roads never settle, as did a certain highway built several years ago across the Dismal Swamp in eastern North Carolina.

As the present methods used in highway construction are comparatively new, research in this particular field of blasting has not been carried on until recently. However, it has been proved that by the careful and proper manipulation of blasting materials, roads may be constructed over swampy lands that are as good, from all points of view, as roads constructed over ordinary dirt or rocky territory.

What two juniors spend most of their spare time at the co-ed shack? And what senior does the same thing?

What engineering Playmaker burned out several large stage lighting bulbs, and then pondered for days on the cause of such a catastrophe?

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